Chapter 6.1

Seagrass abundance and habitat criteria in the Maryland Coastal Bays

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Abstract

Seagrasses have been increasing annually since monitoring began in 1986. General consensus among the scientific community is that, despite recent increases documented by the aerial survey, seagrass coverage is considerably less than in the early 1900s. A disease virtually eliminated eelgrass (*Zostera marinus*) from the Coastal Bays in the 1930's, leading to drastic declines in the acreage covered by seagrasses in general. The 2002 acreage represents the second highest total documented in the Coastal Bays, a 320 % increase since annual data began to be collected in 1986. Even though the 2002 numbers show a decrease, seagrass acreage in Maryland's Coastal Bays has increased steadily since annual monitoring began, declining only four times in the 18 year history of the survey. Although seagrasses are found in four major segments of Maryland's Coastal Bays, they are not distributed evenly. Almost 85 percent of all seagrasses occur along the Assateague Island shoreline in Sinepuxent and Chincoteague Bays.

Introduction

Seagrasses have been monitored annually since 1986 through aerial surveys conducted by the Virginia Institute of Marine Sciences (VIMS) and funded by the States of Maryland and Virginia, and the federal government. Despite recent increases documented by the aerial survey, general consensus among the scientific community is that current seagrass levels are considerably lower than the potential available habitat may allow. In the early 1930's, eelgrass wasting disease virtually eliminated eelgrass (*Zostera marina*) along the east coast including areas in the southern Coastal Bays where it was the dominant species.

Although the historic losses of seagrass are largely attributable to disease rather than water quality changes, water quality conditions play a critical role in seagrass distribution. Light limitation will ultimately determine the extent of Coastal Bay seagrass populations. In the Chesapeake Bay, water quality goals have been established based on depth of light penetration (as an indicator of potential habitat availability). In areas where water quality is suitable for seagrass growth, other factors that may limit seagrass distribution in the Coastal Bays include substrate suitability, percent organic content of the sediment (eelgrass prefers sediment with an organic content <5%; however, widgeon grass has a greater ability to grow on soft, muddy substrates (Hurley 1990)) and exposure (how shallow seagrass can grow is limited by wave energy).

Management Objective: Increase seagrass abundance by maintaining acceptable habitat conditions for seagrass expansion.

Summary of Seagrass Indicators

Abundance Indicator:	Seagrass acreage
Draft coverage Indicator:	percent bottom area covered.
Draft Habitat Indicator 1:	Chlorophyll *a* < 15 µg/L
Draft Habitat Indicator 2:	Dissolved Inorganic Nitrogen < 0.15 mg/L
Draft Habitat Indicator 3:	Dissolved Inorganic Phosphorus < 0.02 mg/L
Draft Habitat Indicator 4:	Total Suspended Solids < 15 mg/L
Draft Habitat Indicator 5:	Secchi >0.966 m or on bottom (>40% of time)
Draft Habitat Index indicator:	Index = 1.0

A. Seagrass Abundance

The abundance and distribution of seagrasses are an important part of the Coastal Bays ecosystem. Seagrasses are used as nursery for many species. Not only do seagrasses improve water quality, they also provide food and shelter for waterfowl, fish and shellfish. For example, research has shown that the density of juvenile blue crabs (*Callenectes sapidus*) is 30 times greater in grass beds than in unvegetated areas (Orth and Montfrans. 2002).

Abundance Data Sets

Seagrasses have been monitored annually in the Coastal Bays by VIMS since 1986 using aerial photography (Orth et al. 2003).

Indicator: Seagrass abundance (acreage)

Abundance Analyses

VIMS digitization of aerial photos (Orth et al. 2003); DNR categorization into bay segment.

Status and Trends of Seagrass Abundance

Total seagrass coverage in the Coastal Bays following the 2002 survey is shown in Figure 6.1.1. Overall, 17,885 acres (10,511 in Maryland) of seagrass were mapped, a nine percent decrease from 2001. Descriptions of abundance in each individual bay segment follow as well as estimates of the amount of bottom area covered by seagrasses.

Assawoman Bay

In 2002, there were 406 acres of seagrass in Assawoman Bay representing an 8% coverage of bay bottom (Figure 6.1.2). Seagrass coverage has increased an average of 43 acres per year since it first appeared in 1991.

St. Martin River

In 2002, there were 2 acres of seagrass in St. Martin River representing a <1% coverage of the bay bottom (Figure 6.1.3). SAV first appeared in St. Martin River along the Isle of Wight Management area in 1999.

Isle of Wight

In 2002, there were 234 acres of seagrass in Isle of Wight Bay representing a 5% coverage of the bay bottom (Figure 6.1.4). Seagrass coverage has increased an average of 21 acres per year since it first appeared in 1992.

Sinepuxent

In 2002, there were 2135 acres of seagrass in Sinepuxent Bay representing a 36% coverage of the bay bottom (Figure 6.1.5). Seagrass coverage has increased an average of 126 acres per year since 1986.

Newport

In 2002, there were 113 acres of seagrass in Newport Bay, which represents 3.5% of bay bottom covered (Figure 6.1.6). Seagrass coverage has increased an average of 7 acres per year since 1990 when it first appeared in Newport Bay along the lower eastern shore of the bay. Large increases have occurred during two distinct periods: first from 1996 to1997 when acreage jumped from an average of 20 acres to 75 acres and between 2000 - 2001 when acreage jumped from an average of 60 acres to 120 acres.

Chincoteague Bay

In 2002, there were 14,995 acres of seagrass in Chincoteague Bay representing a 32% coverage of the bay bottom (Figure 6.1.7). Seagrass coverage has increased an average of 753 acres per year since 1986 when monitoring began.

Seagrass Abundance Summary

Seagrasses are an important indicator of bay health. The largest distribution of seagrass in the Coastal Bays occurs in Chincoteague Bay (14,995 acres) while the largest percent bottom area covered by seagrasses occurs in Sinepuxent Bay (36%) (Figure 6.1.1). Distribution of seagrasses in the northern bays is limited, presumably due to poorer water quality conditions (see Section 4 of this report).

Results for 2002 show that seagrass acreage decreased 6 percent from 2001 to 2002 to approximately 18,087 acres (10,511 acres in Maryland) (Figure 6.1.1). Yet, the 2002 acreage represents the second highest abundance documented by the monitoring program and a 320 percent increase since the survey began in 1986 (Figure 6.1.1). Even though the 2002 numbers show a slight decrease, seagrass acreage in Maryland's Coastal Bays has exhibited a steady increase since annual monitoring began, and has only declined four times in the 16 year history of the survey.

Density is not an MCBP indicator and is therefore not addressed in this report.

An evaluation of percent available habitat being met would be a better indicator of the status of seagrass in the bays than percent bottom area covered. USACE (1998) estimated that 30,000 acres of potential habitat to 1 m depth existed in the coastal bays, however this estimate did not include consideration of substrate type. Bathymetric data used in USACE (1998) was National Ocean Service chart, much better data is now available. Other factors that might be useful to evaluate potential seagrass habitat include sediment type (percent organic composition), depth, historic distribution and wave energy.

B. Seagrass Habitat Criteria

Although seagrasses are found in all four major segments of Maryland's Coastal Bays, they are not distributed evenly. Almost 85 percent of all seagrasses occur along the Assateague Island shoreline. In the northern bays, seagrass abundance is limited presumably due to reduced water quality from human activities.

Increased nutrient inputs from point and non-point sources and sediments in the water column decrease the amount of sunlight reaching seagrasses and are considered the primary threat to seagrass health. Seagrasses in the Coastal Bays may also be damaged by excessive macroalgae, brown tide, and recreational and commercial boating activity. Natural factors, such as sediment type and wave action, also influence the health and location of seagrass beds.

Seagrasses are widespread, ecologically important and sensitive to some environmental variables that are measured in many standard water quality monitoring programs (Dennison *et al*, 1993). Previous studies in the Maryland Coastal Bays have suggested that seagrass distribution and abundance may be limited by high nutrient loading rates

(Boynton *et al*, 1996). Therefore, assessing water quality thresholds based on seagrass habitat criteria provides information about potential maintenance of the ecosystem services associated with seagrass meadows.

Seagrass Habitat Data Sets

Monthly data from 41 Maryland Department of Natural Resources and 18 National Park Service water quality stations was compiled for a three-year time period (2001-2003). Neither data set included data beyond October 2003. The indicators that were used to determine seagrass habitat criteria followed those adopted for the Chesapeake Bay and included Secchi depth, chlorophyll *a* concentration (chl *a*), total suspended solids (TSS), dissolved inorganic nitrogen (DIN), and dissolved inorganic phosphorus (DIP) (Batiuk et al. 2000).

***Draft* Habitat Indicator 1:** Chl *a* < 15 μg/l
***Draft* Habitat Indicator 2:** DIN < 0.15 mg/l
***Draft* Habitat Indicator 3:** DIP < 0.02 mg/l
***Draft* Habitat Indicator 4:** TSS < 15 mg/l
***Draft* Habitat Indicator 5:** Secchi >0.966 m or on bottom (>40% of time)

Seagrass Habitat Analyses

The primary growth of seagrasses in the Coastal Bays occurs from March through November. The growing season is based on the combined temperature requirements for growth of the two species of seagrass species present: *Zostera marina* (March thru May and October thru November) and *Ruppia maritima* (April thru October). Median values for each indicator (except Secchi depth; see below) at each station were evaluated against accepted EPA Chesapeake Bay Program criteria (draft habitat indicators above) over the seagrass growing season for the combined three-year period. Although these were originally established for the Chesapeake Bay, studies by Valdez (1998) and Lea et al (2003) suggest that the nutrient thresholds are similar in the Coastal Bays, however, the TSS and secchi indicator thresholds may differ between the two systems.

Because the Secchi disk was frequently visible on the bottom, traditional median values could not be used. Specifically, median Secchi depths would have masked measurements "on bottom," suggesting conditions were worse than in reality. For the current analyses, bottom measurements "on bottom" were determined to always indicate adequate seagrass light penetration. Therefore, a percentage of samples that exceeded the Secchi threshold over the three-year period was adopted as a threshold. Samples designated as "on bottom" were always included as meeting the threshold.

Attainment of habitat criteria (except Secchi depth) was tested using a non-parametric Wilcoxon test for position, which compared the three-year medians against the individual criteria. This test determined if water quality conditions at an individual site was significantly different from the criteria being used. The Wilcoxon test was more sensitive to the consistency of the differences (positive or negative) than to their magnitude (Batiuk *et al.* 2000).

Results were classified into four groups (listed below) using a two-tailed significance level of 0.05. The results of the statistical analyses are summarized in Table 6.1.1.

Met – Median was significantly below the criterion

Borderline Met – Median below criterion but not significantly different from the criterion

Borderline Not Met – Median above criterion but not significantly different from criterion

Not Met – Median was significantly above the criterion

Status of Seagrass Habitat Criteria

Assawoman Bay

In Assawoman Bay, the open bay station nearest existing seagrass beds (XDN4851) met all but one habitat criteria while most of the remaining Assawoman Bay stations were either poor or degraded in relation to seagrass habitat thresholds (Table 6.1.1).

St. Martin River

The St. Martin River showed most sites failed seagrass habitat thresholds or water quality variables (Table 6.1.1). Three sites were very degraded, four sites degraded, five poor and only one good with regard to seagrass habitat criteria. This agreed with observations that there was very minimal seagrass growing within this segment.

Isle of Wight Bay

In Isle of Wight Bay there were poorer conditions in the tributaries with little seagrass and fewer habitat criteria being met in Herring and Turville Creeks. Better conditions existed in the open bay with evident seagrass beds and a higher proportion of met habitat criteria along the eastern shore, despite the presence of heavy urbanization (Table 6.1.1). Here, as in Chincoteague Bay, sediment and physical characteristics may play a role with silty sediments dominating Turville and Herring creeks in the west and sandier sediments more prevalent along the eastern portion of the bay (Wells et al. 1994).

Sinepuxent Bay

All stations in Sinepuxent Bay met all criteria except one (TSS at ASIS 17 did not meet the criteria, but was not significantly different from the criteria either) (Table 6.1.1). Noticeably absent were seagrass beds around the two stations nearest the Ocean City inlet (ASIS 1 and ASIS 17), despite meeting most of the habitat criteria. The strong currents coming from the inlet probably make this area unsuitable for seagrass growth and may also contribute to the elevated TSS levels at site ASIS 17.

Sinepuxent stations also have some of the highest percentage values for Secchi criteria attainment among the stations. This could be a result of the shallow water depth in Sinepuxent Bay when compared to the other bays, and the flushing with "clear" ocean water but this remains an interesting characteristic when determining seagrass habitat suitability.

Newport Bay

Stations in the upper tributaries of Newport Bay did not meet or were categorized as borderline for more than one criteria (Table 6.1.1). Attainment of Secchi depth criteria tended to be lower in these upstream waters as well. The two stations in the Bay proper either met or were borderline for most thresholds. As expected, the station nearest the existing seagrass beds along the western edge of South Point (ASIS 3) had the most thresholds met and a relatively high Secchi depth percentage. However, this station was still a fair distance from existing seagrass beds.

Chincoteague Bay

Generally, stations with a majority of criteria met were in close proximity to existing seagrass beds (see previous section on seagrass abundance). However, several stations not near seagrass beds also demonstrated generally good conditions for seagrass growth (Table 6.1.1). For instance, Assateague Island stations 7, 14, 9, and 10 along the western shore of Chincoteague Bay generally met most criteria for water quality and had relatively high percentages of Secchi depth meeting or exceeding the criteria. There is little seagrass growing near these stations (Table 6.1.1).

Seagrass Habitat Criteria Summary

Although stations along the western shore of Chincoteague Bay generally met most criteria for water quality and had relatively high percentages of Secchi depth meeting or exceeding the criteria, there were few seagrass beds present. Several explanations for this are possible. First, the small amounts of seagrass growing along the western shore of Chincoteague could be poised to expand due to improved habitat conditions. However, indicators of water quality (see Chapter 4.1) suggest no trend prior to the three-year period used for this analysis. Another possible explanation could be that since this eelgrass habitat analysis only includes water quality and clarity indicators, physical habitat characteristics conducive to seagrass growth, such as sediment characteristics or hydrology were not considered. Sediment type as well as other factors can play roles in the presence of seagrass. For instance, some types of seagrass (eelgrass specifically) are documented to have less success growing in silty, organic-rich sediments (Batiuk et al. 2000). The sediment of the western shore of Chincoteague Bay tends to have a higher proportion of silt than the sandy eastern portions of the bay (Wells et al. 1998). In addition, there is a high input of organic matter from eroding marsh peats in some areas.

Sediment and physical characteristics may also play a role in seagrass distribution in the St. Martin River and Isle of Wight Bay. Silty sediments dominate the St. Martin River, Turville and Herring creeks in the west and sandier sediments predominate along the eastern portion of the bay (Wells et al. 1994). In Assawoman Bay, the station nearest existing seagrass beds (XDN4851) meets all habitat criteria but all the stations remaining do not meet at least one and are not near seagrass beds.

The low proportions of Secchi depth percentages meeting the threshold across all stations regardless of seagrass presence serves as a warning that criteria developed for the Chesapeake Bay may not suffice. Secchi depth data were found to be problematic due to the lack of quantitative measure associated with instances of "on bottom" measurements. In fact, at some stations the minimum criterion exceeded the station depth. In response to this issue, a percentage time Secchi passed the criterion was adopted. All "on bottom" measurements were considered to have adequate water clarity for seagrass growth and were grouped as passing the criterion. Secchi depth results were reported simply as the percentage of measurements over the three-year period that passed the criterion. Additionally, coefficients to convert secchi depth to light attenuation (K_d) were thought to be variable in the Coastal Bays based on the dominant sediment material resuspended in the water column.

We recommend measuring photosynthetically active radiation (PAR) directly at all stations using a simultaneous, two depth setup in order to calculate percent light in water directly. A three year study by Lea *et al* (2003) suggests that the K_d habitat criteria in the Coastal Bays (1.38) is less than that in the Chesapeake Bay (1.50) and is potentially limiting seagrass growth in some areas of the Coastal Bays.

Bay Segment	Station	SECCHI	TSS	CHLA	DIP	DIN
Assawoman Bay	XDN4851	28%				
	XDN5737	24%				
	XDN6454	24%				
	XDN7261	29%				
	XDN7545	28%				
	GET0005	#####				
St. Martin River	BIH0009	#####				
	BNT0012	#####				
	BSH0008	16%				
	BSH0030	0				
	MXE0011	#####				
	SPR0002	12%				
	SPR0009	8%				
	XDM4486	12%				
	XDN3724	36%				
	XDN4312	27%				
	XDN4797	15%				
Isle of Wight Bay	HEC0012	23%				
	MKL0010	42%				
	TUV0011	31%				
	TUV0019	58%				
	TUV0034	#####				
	XDN0146	46%				
	XDN2340	27%				
	XDN2438	42%				
	XDN3445	31%				
Sinepuxent Bay	ASIS 1	44%				
	ASIS 2	56%				
	ASIS 16	44%				
	ASIS 17	48%				
	ASIS 18	52%				
Newport Bay	AYR0017	4%				
	MSL0011	8%				
	NPC0012	12%				
	NPC0031	15%				
	TRC0043	8%				
	TRC0059	53%				
	XCM4878	24%				
	ASIS 3	22%				
	ASIS 4	30%				

Bay Segment	Station	SECCHI	TSS	CHLA	DIP	DIN
Chincoteague Bay	XBM1301	36%				
	XBM3418	40%				
	XBM5932	28%				
	XBM8149	28%				
	XCM0159	28%				
	XCM1562	36%				
	ASIS 5	37 %				
	ASIS 6	41 %				
	ASIS 7	37 %				
	ASIS 8	59 %				
	ASIS 9	44 %				
	ASIS 10	48%				
	ASIS 11	67%				
	ASIS 12	70%				
	ASIS 13	70 %				
	ASIS 14	37 %				
	ASIS 15	41 %				

Met	Borderline Met	Borderline Not Met	Not Met	Insufficient Data
				#####

Table 6.1.1: Coastal Bays seagrass habitat criteria test results for all current Coastal Bays stations 2001-2003. The Secchi depth test is the percentage of samples (station per month per year) passing at the 0.966 m criterion with samples that were "on bottom" automatically passing. For all other indicators, statistical results are summarized by station using the color-shaded chart.

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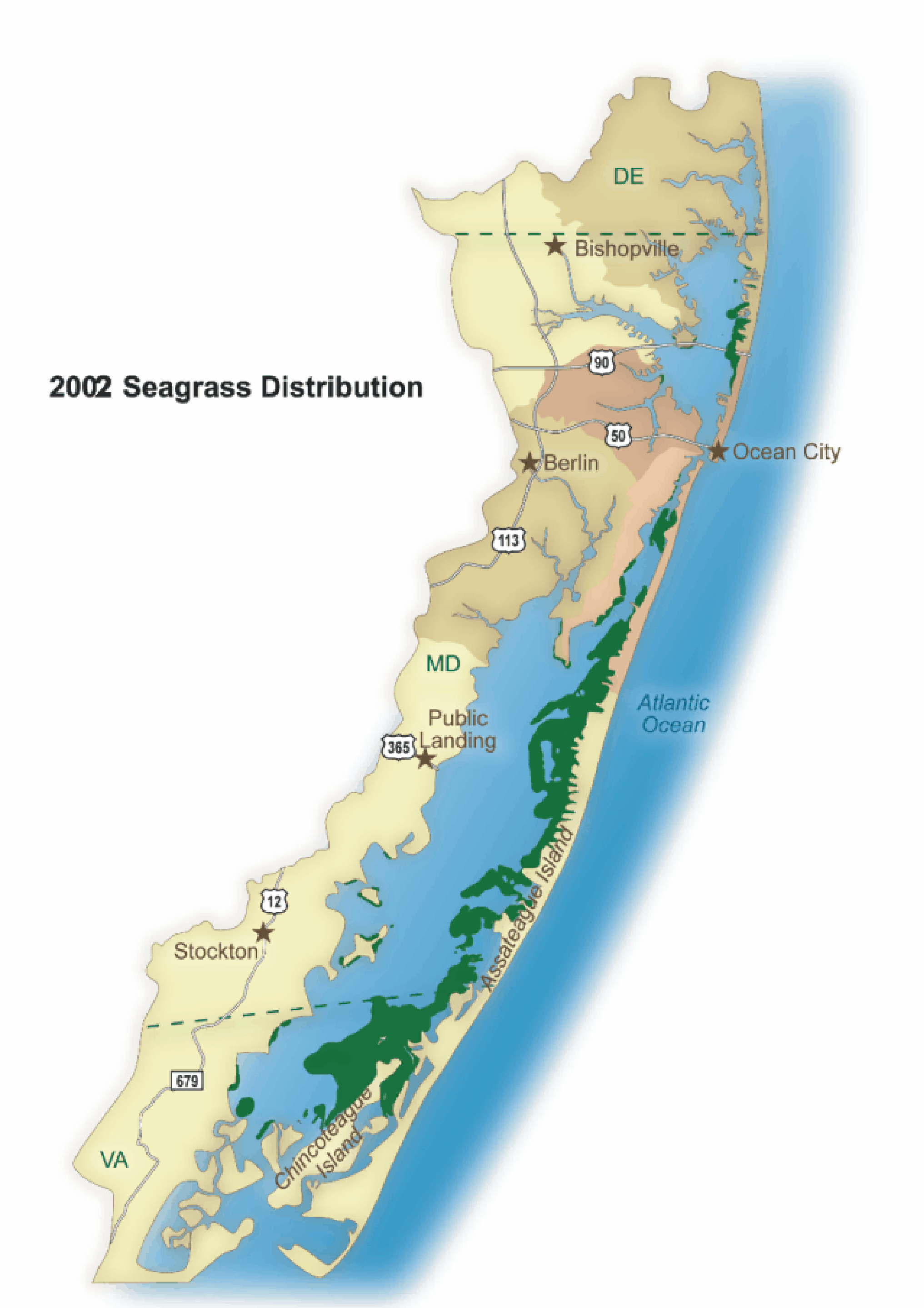

Figure 6.1.1: Total seagrass coverage in the Coastal Bays as discerned from 2002 Virginia Institute of Marine Science aerial survey.

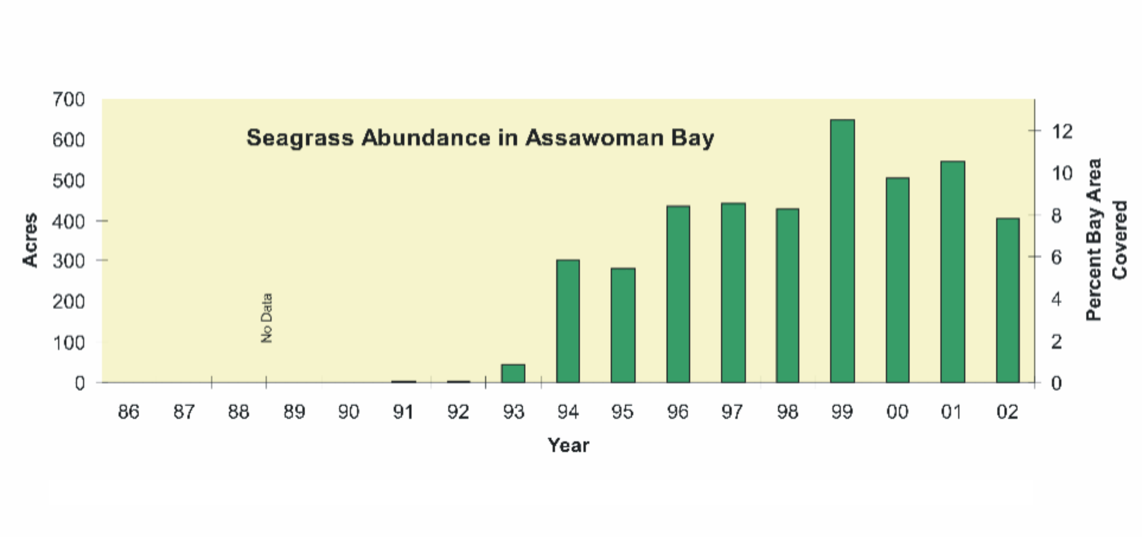

Figure 6.1.2: Annual seagrass acreage (left y-axis) and percent bottom area covered (right y-axis) in Assawoman Bay.

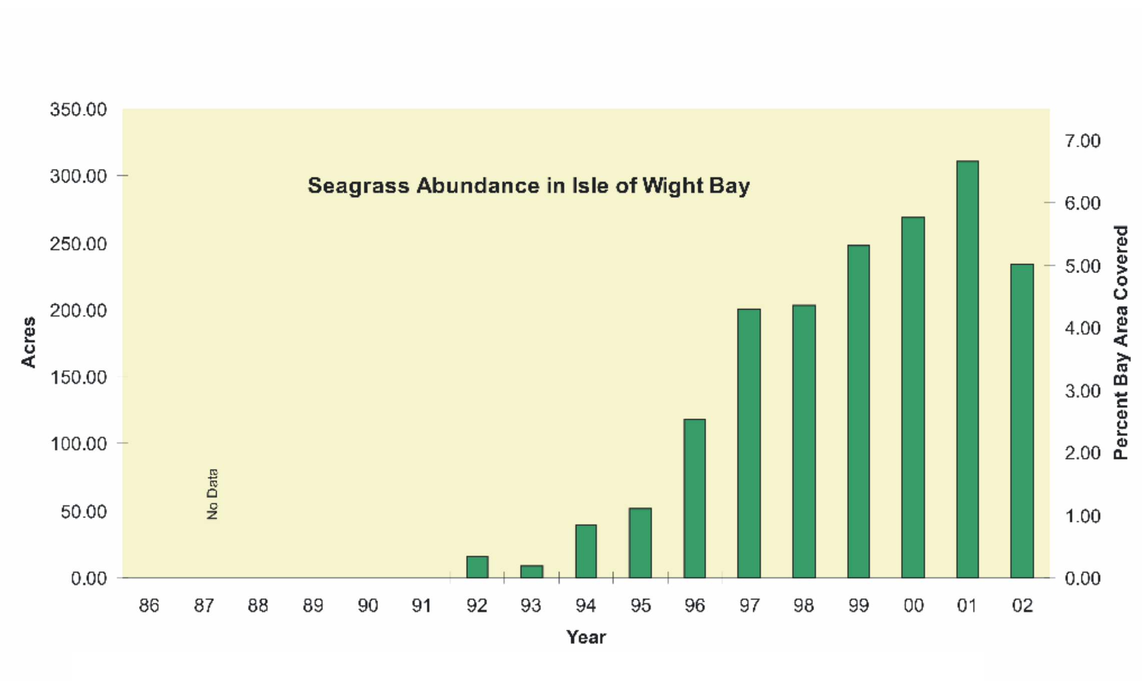

Figure 6.1.3: Annual seagrass acreage (left y-axis) and percent bottom area covered (right y-axis) in Isle of Wight Bay.

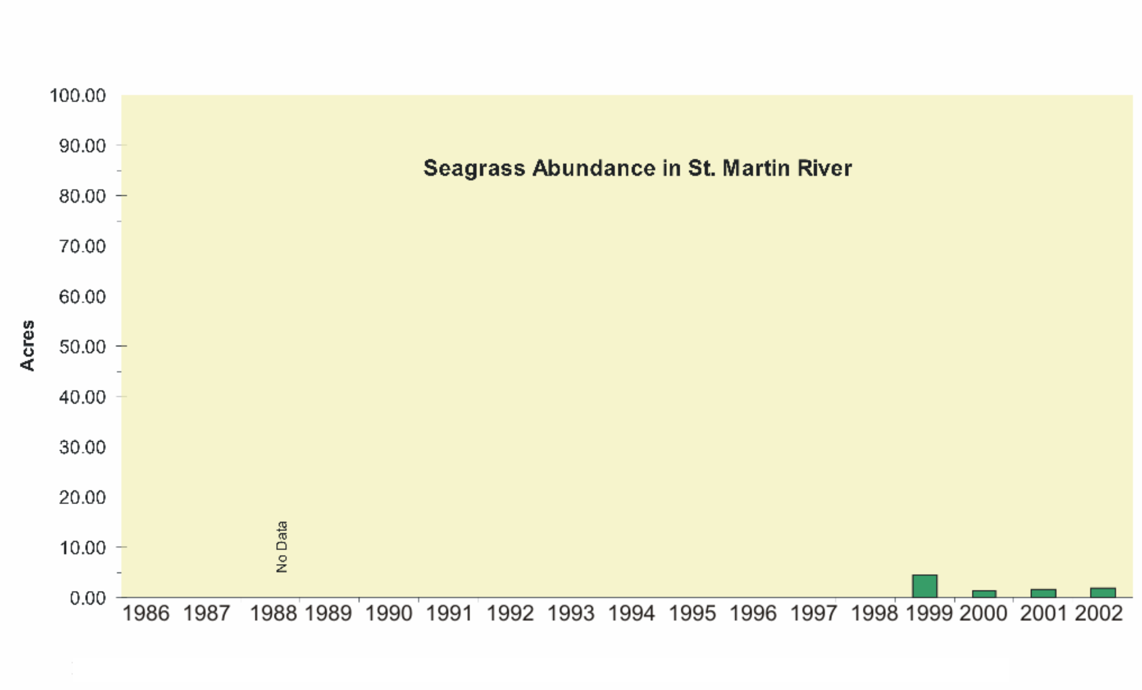

Figure 6.1.4: Annual seagrass acreage (left y-axis) and percent bottom area covered (right y-axis) in the St. Martin River.

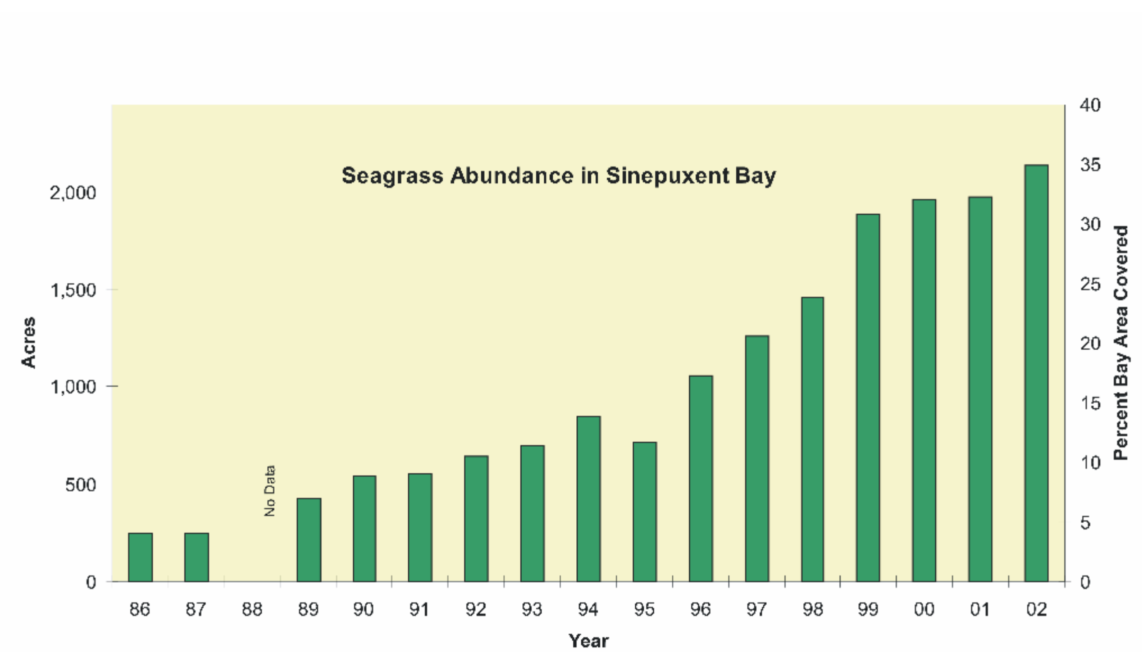

Figure 6.1.5: Annual seagrass acreage (left y-axis) and percent bottom area covered (right y-axis) in Sinepuxent Bay.

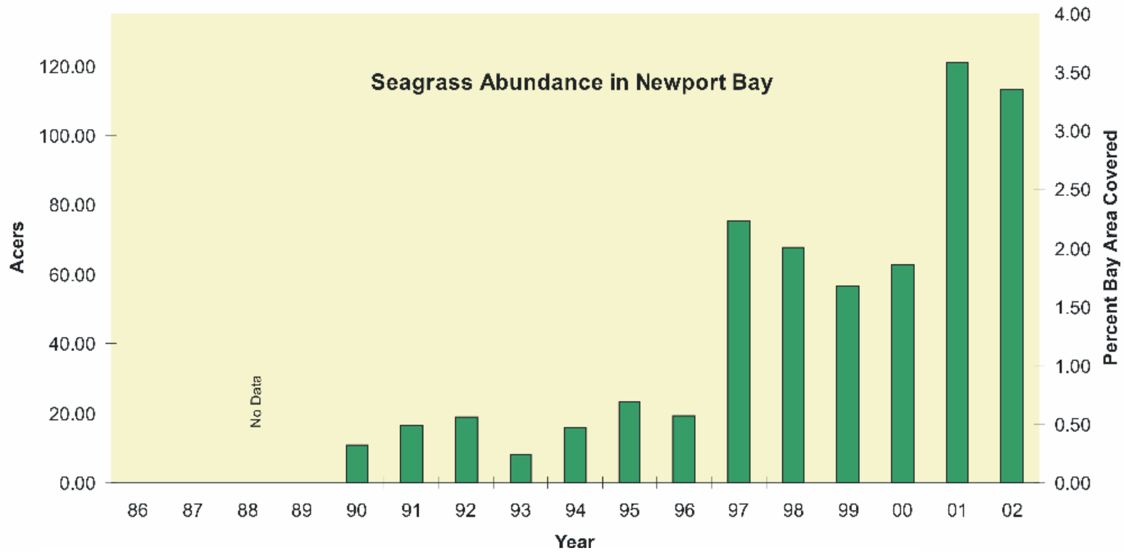

Figure 6.1.6: Annual seagrass acreage (left y-axis) and percent bottom area covered (right y-axis) in Newport Bay.

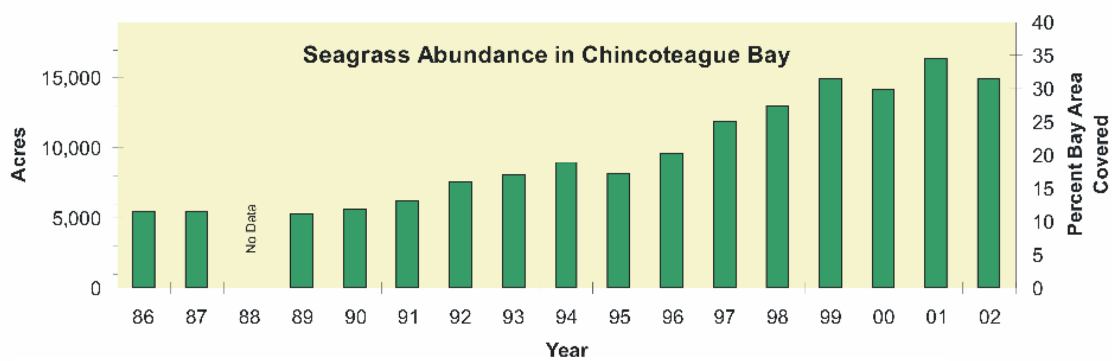

Figure 6.1.7: Annual seagrass acreage (left y-axis) and percent bottom area covered (right y-axis) in Chincoteague Bay.